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For

CIGARETTE HAVING REDUCED SIDESTREAM SMOKE

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CIGARETTE HAVING REDUCED SIDESTREAM SMOKE

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BACKGROUND

The present invention relates generally to a cigarette with reduced combustion of smoking material during quiescent periods between puffing. The invention also pertains to a cigarette having regulated combustion of smoking material between and during puffing.

A typical cigarette contains 750 mg to 800 mg of tobacco. Approximately 20 mg of this tobacco is burned during a puff, while approximately 50 mg is consumed between puffs. The smoke generated by the burning tobacco during a puff is termed "mainstream smoke", while the smoke generated between puffs is termed "sidestream smoke". Since a large portion of the tobacco is wasted during quiescent periods between puffs, practitioners have attempted to reduce the combustion of tobacco during these quiescent periods.

Commonly assigned U.S. Patent No. 5,159,940 to Hayward et al. presents one technique for reducing sidestream smoke in a cigarette. As shown in Figure 1, the cigarette **2** disclosed in this patent consists of a tubular member **4** comprised of plural sections. A first section is comprised of a heat source **10** composed substantially of carbon. The heat source **10** may also contain catalysts or burn additives to promote combustion. The heat source **10** is secured to the tubular member **4** by a retaining

member **16**, such as metal clips. A second section of the cigarette **2** includes a substrate **14**, which comprises tobacco filler mixed with an aerosol precursor, such as glycerine or propylene glycol. A third section of the cigarette **2** comprises an expansion chamber **8**. A fourth section comprises a mouthpiece filter **6**, such as a cellulose acetate filter.

The above-described cigarette functions in the following manner. A user ignites the heat source **10**, upon which the carbonaceous material begins to burn and generate heat. The heat generated by the heat source **10** vaporizes the aerosol precursor in substrate **14** and gases are generated containing flavor extracted from the tobacco in the substrate **14**. The gases are drawn into the expansion chamber **8**, where the gases expand and cool to form an aerosol **12**. The aerosol **12** is drawn out through the filter **6** for delivery to the user. This cigarette thus operates by generating a flavored aerosol rather than burning the tobacco product in a conventional manner. As such, this cigarette generates little or no sidestream smoke while being consumed.

Another cigarette having reduced sidestream smoke is disclosed by U.S. Patent No. 5,105,835 to Drewett et al. The cigarette disclosed therein also uses a heat source composed of a carbonaceous material. The heat source in this device is inserted within a plug of tobacco and is in contact with the tobacco. A wrapper of low permeability surrounds the plug of tobacco to restrict the amount of oxygen which passes through the wrapper to the underlying tobacco and heat source, thus preventing free smoulder of the tobacco.

The above-described cigarette functions in the following manner. The consumer lights the heat source and the smoking material. During a puff, both the heat source and

the smoking material burn to deliver flavor to the consumer. When the user stops puffing, however, insufficient oxygen reaches the tobacco material to sustain its combustion. The tobacco, therefore, stops burning during such quiescent periods. The carbonaceous heat source, on the other hand, has sufficient thermal energy to remain burning. When the user takes another puff on the cigarette, increased oxygen is fed to the heat source, which increases its rate of combustion and the amount of heat generated thereby. This increased heat re-ignites the tobacco. Thus, this device reduces sidestream smoke between puffs and also delivers flavor in a conventional manner by burning tobacco.

The use of relatively thick and/or low permeability wrappers or shells in both of the above-described cigarettes generally reduces the influx of oxygen to the interior of the cigarettes. Thus, in the exemplary case of Drewett, despite the use of small perforations in the outer wrapper, this cigarette may non-uniformly burn the tobacco from puff to puff depending on the strength of the puff and other variables.

Accordingly, it is an exemplary object of the present invention to provide a cigarette having reduced sidestream smoke which has more uniform and controllable combustion characteristics.

SUMMARY

This and other exemplary objectives are achieved according to the present invention through a cigarette including an ignition element disposed within a plug of

tobacco, which, in turn, is disposed within one or more layers of cigarette paper. A perforated wrapper is then wrapped around the cigarette paper layer(s), such that the inner cigarette paper initially blocks the perforations in the outer wrapper and thereby prevents oxygen from reaching the interior of the cigarette. Other materials can be used to block the perforations besides the paper layer(s), such as waxes or films.

In a preferred embodiment, the perforated outer wrapper has a permeability selected to provide enough oxygen to the ignition element to sustain its combustion in quiescent periods between puffs, but to provide insufficient oxygen to sustain combustion in the tobacco between puffs. Thus, the tobacco is extinguished (or subject to a reduced rate of combustion) between puffs, thereby eliminating or greatly reducing the amount of sidestream smoke generated by the cigarette. When a user takes a puff on the cigarette after a quiescent period, oxygen is fed to the ignition element, which increases its rate of combustion and temperature. This, in turn, re-ignites the tobacco. To perform in this manner, an ignition element is selected which possesses different thermal characteristics in a low oxygen environment compared to the tobacco. Generally, an ignition element is selected which is less readily extinguished in a low oxygen environment compared to the tobacco. In one exemplary embodiment, the ignition element comprises a carbon element inserted in the plug of tobacco.

During use of the cigarette, the heat generated by the ignition element and tobacco undergoing combustion burns away the paper blocking the perforations, thereby exposing the perforations and creating passageways which allow oxygen to reach the interior of the cigarette through the outer wrapper. The perforations are "opened" in

successive fashion as the ember of the ignition element advances inward from the distal end of the cigarette. That is, perforations located at the distal end of the cigarette are opened first, followed by perforations located successively further inward from the distal end. In this manner, oxygen is made available to the ignition element even when the burning portion of the ignition element is recessed within the outer wrapper. Initially, however, perforations located inward from the distal end are closed, such that air will not be drawn undesirably through the base of the cigarette. Accordingly, the cigarette of the present invention reduces sidestream smoke while providing uniform and controllable combustion characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing, and other, objects, features and advantages of the present invention will be more readily understood upon reading the following detailed description in conjunction with the drawings in which:

Figure 1 shows a device for generating a flavored aerosol according to the prior art;

Figure 2(a) shows a first embodiment of a cigarette according to the present invention;

Figure 2(b) shows a cross-section of the cigarette of Figure 2(a);

Figure 3(a) shows a second embodiment of a cigarette according to the present invention;

Figure 3(b) shows a cross-section of the cigarette of Figure 3(a);

Figure 4 shows an exemplary construction of a composite outer wrapper for use in the cigarettes of the present invention;

Figure 5(a) shows an exemplary layout of perforations in the composite outer wrapper according to a first embodiment;

Figure 5(b) shows an exemplary layout of perforations in the composite outer wrapper according to a second embodiment; and

Figure 5(c) shows an exemplary layout of perforations in the composite outer wrapper according to a third embodiment.

DETAILED DESCRIPTION

In the following description, for purposes of explanation and not limitation, specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one skilled in the art that the present invention can be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods and devices are omitted so as not to obscure the description of the present invention with unnecessary detail. In the figures, like numbers designate like parts.

Figure 2(a) shows a perspective view of a cigarette **30** according to a first embodiment of the present invention, and Figure 2(b) shows a cross-section view of this cigarette **30**. According to exemplary embodiments, the cigarette **30** is approximately 83 mm long and contains four main sections. A first section **41** includes tobacco **40** (or a tobacco-based material) and an ignition element **36** in contact with the tobacco **40**.

This section joins a second section **42**, which contains only tobacco. The next section **44** comprises a hollow tube, such as a cellulose acetate fiber tube. Finally, section **44** joins a filter section **46**, which can comprise a conventional filter section (e.g., comprising a cellulose acetate filter). According to exemplary embodiments, the first section **41** is approximately 21 mm in length, the second section **42** is approximately 10 mm in length, the third section **44** is approximately 22 mm in length, and the last section **46** is approximately 30 mm in length.

Carbon or carbon-based compounds are generally suitable materials for use in forming the ignition element **36**. Salts, such as the carbonates and/or acetates of potassium and/or sodium, can be used to modify the onset combustion temperatures of the carbon-based ignition element **36**. More generally, any material or compound can be used for forming the ignition element **36** providing that this element is less readily extinguished in a low oxygen environment compared to the tobacco **40**. This may equate to the ignition element **36** having a longer "static burn time" compared to the tobacco **40** in a low oxygen environment. In another embodiment, for example, the ignition element **36** can comprise a plug of tobacco having a longer static burn time than the surrounding tobacco material **40**. This can be achieved by treating the tobacco materials with various combustion retardants and/or promoters to achieve a desired burn rate ratio between an inner and outer tobacco sections.

With reference to both Figures 2(a) and 2(b), the ignition element **36** according to the first exemplary embodiment comprises a cylindrical rod which spans the length of the first section **41** (e.g., approximately 21 mm). The ignition element **36** is

approximately 50 mg in weight and has a diameter of approximately 3 mm. The axis of the ignition element **36** coincides with the axis of the cigarette **30**. However, those skilled in the art will appreciate that the ignition element **36** can be formed in different shapes. For instance, the ignition element **36** can comprise a plurality of smaller rods located within the first section **41**, or can comprise one or more strips of material located within the first section **41**.

One or more layers of cigarette paper (denoted generally as paper **32**) cover the various sections containing tobacco **40**. The cigarette paper **32** can comprise any conventional cigarette paper, or can comprise low sidestream cigarette paper such as a high basis weight paper containing calcium carbonate (e.g., at approximately 53 g/m^2). As those skilled in the art will appreciate, various other layers of paper and matings can be used to cover the various sections **41**, **42**, **44**, and **46**.

A composite outer wrapper **38** is then wrapped around the inner cigarette paper **32**. As shown in Figures 2(a) and 2(b), the composite outer wrapper **38** preferably covers the tobacco in sections **41** and **42**. More specifically, the composite outer wrapper **38** in this embodiment runs from the exposed distal tip of section **41** to a few millimeters beyond the end of section **42**. In the cigarette **31** shown in Figures 3(a) and 3(b), however, the composite outer wrapper **38** starts approximately 1 mm to 5 mm from the exposed tip of section **41**. Leaving a section of the tip exposed allows oxygen to more readily permeate the tip of the cigarette. This makes it easier to initially light the cigarette. It should be noted that Figures 2(a) and 3(a) show the composite outer wrapper **38** partially removed from the cigarette (**30**, **31**) to better illustrate the

composite outer wrapper **38**. During use, however, the composite outer wrapper **38** is wrapped entirely around the cigarette (**30**, **31**).

As shown in Figure 4, in the preferred embodiment, the composite outer wrapper **38** comprises a three-ply material formed from a layer **52** of metal foil interposed between two layers (**50**, **54**) of low sidestream paper (such as paper containing a calcium carbonate filler at approximately 53 g/m^2), or other type of paper. According to preferred embodiments, the metal foil is formed from a sheet of aluminum foil having a thickness of approximately 0.00025 to 0.002 inches, although thinner or thicker foils can be used. The three layers can be laminated together with a suitable adhesive, such as polyvinyl acetate adhesive.

The metal foil **52** serves three principal purposes. First, the foil **52** is substantially impervious to oxygen. Thus, the foil **52** creates a low oxygen environment within the cigarette between puffs by blocking the flow of oxygen into the cigarette through the side walls of the cigarette. Second, the foil removes and dissipates heat from the ignition element **36** and the tobacco **40**. This promotes the quick reduction in combustion rate of the tobacco **40** after a puff. Third, the foil **52** shields the outer paper layer **50** from the ignition element **36**, and helps to reduce the charring of the outer paper layer **50** caused by the heat generated by the ignition element **36**. The reduction in charring is proportional to the thickness of the foil **52**. Relatively thick foils **52** will produce minimal charring of the paper layer **50**. This results in minimal discoloring of the paper layer **50**. Thinner layers may produce some discoloration (i.e. tanning or blackening) of the paper layer **50**. The degree of charring

is also directly proportional to the number of perforations in the wrapper (to be discussed in greater detail below).

In other embodiments, instead of a three-ply wrapper, an outer laminated wrapper comprising a single layer of paper and a single layer of foil can be used, or just a single layer of foil or other material can be used. Furthermore, other materials can be used to form the outer wrapper besides metal foil, such as ceramic-based layers or other substantially non-combustive materials.

With reference again to Figures 2(a) and 3(a), the composite outer wrapper **38** preferably includes a number of perforations **34**. In the exemplary embodiments shown in these figures, the perforations **34** comprise a plurality of small apertures. These perforations **34** provide passageways into the interior of the cigarette to allow a limited amount of oxygen to reach the underlying tobacco **40** and ignition source **36** through the sides of the cigarette. However, the cigarette paper **32** lies between the wrapper **38** and the tobacco **40**, and therefore initially blocks the passageways. After a series of puffs, the heat generated by the ignition element **36** and the tobacco **40** burns the cigarette paper **32** beneath the perforations **34**, thereby opening up the passageways. More specifically, the perforations **34** are "opened" in successive fashion as the ember of the ignition element and the portion of the tobacco bed undergoing combustion advances from the distal end of the cigarette toward the mouthpiece end of the cigarette. That is, perforations located at the distal end of the cigarette are opened first, successively followed by perforations located further inward from the distal end. In this manner, oxygen is made available to the ignition element even when the combustive portion of

the ignition element is recessed within the outer wrapper. Initially, however, perforations located inward from the distal end of the cigarette are closed, such that air will not be drawn undesirably though the base of the cigarette. Accordingly, the cigarette of the present invention reduces sidestream smoke while providing uniform combustion characteristics.

The size and position of the perforations **34** can be selected to achieve different burn rates. Generally, the influx of oxygen can be evenly distributed to provide a uniform burn rate by using many relatively small perforations, or by using a plurality of tiers of small perforations having different dimensions. For instance, a plurality of evenly dispersed square perforations having dimensions of approximately 0.5 mm by 0.5 mm can be used. In one exemplary embodiment, the perforations begin approximately 1 mm from the left-most edge of the wrapper **38** (with reference to the graphical depictions of Figures 2(a) and 3(a)) and end approximately 7 mm to 15 mm from the left-most edge of the wrapper **38**. The ignition element **36** preferably extends at least a short distance beyond the end of the perforations **34**.

The perforations **34** are shown as having a substantially square shape, but other shapes can be used. The perforations **34** can have circular or oval shapes, slot-like shapes, or other shapes, or different shapes can be used on the same wrapper at different regions. Furthermore, the perforations **34** are illustrated as forming orderly rows, but the perforations can be dispersed over the surface of the composite outer wrapper **38** in other patterns, or randomly dispersed over the surface.

Figure 5(a) illustrates the wrapper **38** of Figures 2(a), 2(b), 3(a) and 3(b) including a plurality of perforations **34**. In one exemplary embodiment, the perforations begin approximately 1 mm from the "top" or distal end of the wrapper **38** and end approximately 7 mm to 15 mm from the top of the wrapper **38**. These perforations can have any desired dimensions as mentioned above. For instance, square perforations having dimensions of 0.5 mm by 0.5 mm can be used, where each perforation is separated from its neighboring perforation by 0.5 mm. These dimensions are exemplary, however, and those skilled in the art will appreciate that other dimensions may be appropriate.

Figure 5(b) shows another embodiment which includes different tiers of small perforations having different dimensions. As shown there, the perforations **71** comprising a first section of perforations have smaller openings ("sizes") than the perforations **73** comprising a second section of perforations. For instance, the perforations **71** can comprise square openings having dimensions of 0.5 mm by 0.5 mm, while the perforations **73** can comprise square openings having dimensions of 1.0 mm by 1.0 mm. These larger perforations **73** deliver more oxygen to those portions of section **41** which are remote from the exposed tip of the cigarette. These larger perforations **73** may be desirable to enhance the delivery of oxygen to more recessed portions of the ignition element **36**. The portions of the section **41** located closer to exposed tip of the cigarette receive more oxygen from the exposed tip, and therefore smaller perforations **71** will suffice in these portions. Only two gradations of

perforations (71, 73) have been shown. However, those skilled in the art will appreciate that three or more different sized perforations can be used.

Figure 5(c) shows another embodiment of the composite outer wrapper 38 having a different arrangement of perforations formed thereon. More specifically, the composite outer wrapper 38 includes the same array of perforations 34 shown in Figure 5(a). Additionally, the composite outer wrapper 38 also includes a series of larger perforations 64 further back from the tip of the cigarette. These larger perforations 64 are located approximately 15 mm from the tip of the cigarette. With reference to Figure 2(a), these larger perforations 64 are located approximately at position 43 denoted as "x". A supplemental film or wax (or other material) may cover these perforations 64.

As mentioned above, when the outer wrapper 38 is wrapped around the inner cigarette paper, the perforations in the outer wrapper are occluded by the inner paper. This initially prevents oxygen from reaching the interior of the cigarette through the perforations. During use, the ignition element and the tobacco material around it reach sufficient thermal energy to burn the paper from beneath the perforations. Typically, the perforations located closest to the burning end of the ignition element and surrounding tobacco (i.e., the portion of the cigarette with the greatest thermal energy) will open first. Thus, the perforations located at the distal end of the wrapper will typically open first, followed by successively more inward perforations as the burning coal of the ignition element advances into the interior of the wrapper.

However, it should be noted that perforations need not be opened in the above-described sequence. Namely, perforations which are axially displaced from the ember may be opened. For instance, if the ignition element and the surrounding tobacco acquire sufficient thermal energy, the larger perforations **64** shown in Figure 5(c) can open, even though the ember may be located toward the distal end of the cigarette. Upon the opening of these larger perforations **64**, air is drawn into the cigarette from the base of the cigarette. During a draw, therefore, some air will flow through the cigarette behind the plug of partially burned tobacco. This will decrease the flow of oxygen axially passing through the cigarette and the burning ignition element. This has the end result of extinguishing the cigarette. Alternatively, smaller perforations **64** can be used which will serve to reduce the rate of combustion in the cigarette, rather than entirely extinguish the cigarette.

The occluding cigarette paper **32** has been discussed above as blocking the perforations from the underside of the outer layer **38**. However, the cigarette paper **32** which blocks the perforations can be located on top of the outer wrapper **38**. Alternatively, the perforations in the outer layer **38** can be blocked from both the inner and outer surfaces of the outer layer **38**.

Finally, instead of cigarette paper **32**, or supplemental to the cigarette paper **32**, occlusions can be formed blocking the perforations in the outer wrapper layer by filling in the perforations with some material which burns or melts when exposed to thermal energy from the ignition element. For example, a cellulosic or wax-like material can be formed in the perforations.

Having discussed the structural components of the cigarette, the operational characteristics of this device will now be discussed in greater detail.

In use, a consumer lights the end of the cigarette (**30, 31**) with a lighter or other suitable device while preferably simultaneously puffing on the cigarette. At this point, the portions of the cigarette paper **32** beneath the perforations **34** are intact, and therefore the air drawn into the cigarette originates primarily from the exposed open end of the cigarette. This makes it easy to light the ignition source **36** and the tobacco **40**.

After the consumer's initial puff, the tobacco may continue to burn unassisted for a short time due to the close proximity of the open end of the cigarette and the availability of oxygen from the open end. In this regard, the cigarette **31** shown in Figures 3(a) and 3(b) will burn longer unassisted than the cigarette **30** shown in Figures 2(a) and 2(b) due to the length of exposed cigarette paper **32** near the tip.

The availability of oxygen decreases, however, as the coal of the ignition element advances down the cigarette beneath the composite outer wrapper **38**, which is substantially impervious to oxygen and other gases. This lack of oxygen will reduce and eventually extinguish the combustion in the tobacco **40**. This is accelerated by the use of the aluminum foil **52** (of Figure 4), which draws thermal energy quickly away from the tobacco **40**. However, the carbon-based composition of the ignition element **36** allows the ignition element **36** to remain burning during quiescent periods between puffs. Alternatively, the carbon-based material may not actually burn during the quiescent periods, but may simply retain sufficient thermal energy to re-ignite the

tobacco **40** when the consumer takes another puff on the cigarette. This can be satisfied by selecting the composition, mass and dimensions of the ignition element **36** such that its temperature does not drop below its re-ignition temperature (i.e., approximately 250°-300°C in one exemplary embodiment). For frame of reference, the ignition element **36** can rise to temperatures between approximately 700°C to 900°C during a puff in one exemplary embodiment.

When the user does take another draw on the cigarette, air axially flows through the cigarette, supplying oxygen to the ignition element **36** and the tobacco **40**. This influx of oxygen increases the combustion rate of the ignition element **36**, which, in turn, re-ignites the tobacco **40**. When the user finishes his or her puff, the tobacco **40** again is extinguished.

During the first few initial puffs, the ignition element **36** generates sufficient heat to burn out the cigarette paper **32** which lies beneath at least the distal-most section of the perforations **34** in the composite outer wrapper **38**. These opened passageways supply additional oxygen to the ignition element **36** between puffs and during puffs, and thereby allow the ignition element **36** to remain lit as the coal advances further into the interior of the cigarette.

If the ignition element acquires sufficient thermal energy, perforations located axially displaced from the ember may be opened. For instance, if the ignition element acquires sufficient thermal energy, the larger perforations **64** shown in Figure 5(c) can open, even though the ember of the ignition element may be located near the distal end of the cigarette. Upon the opening of these larger perforations **64**, air is drawn into the

cigarette from the base portion of section **41** of the cigarette. During a draw, therefore, some air will flow through the cigarette behind the plug of partially burned tobacco. This will decrease the flow of oxygen axially passing through the cigarette and the burning ignition element **36**. This has the end result of extinguishing the cigarette for relatively large perforations **64**. The larger perforations **64** can also be opened when the ember of the ignition element **36** advances close enough to the larger perforations **64** to burn the paper **32** disposed beneath these perforations.

Because the tobacco **40** is extinguished between puffs, very little tobacco **40** is wasted. In one embodiment, 250 mg of tobacco can be used to provide eight or nine puffs, whereas a conventional cigarette requires 700 to 800 mg of tobacco to provide the same number of puffs.

Furthermore, the use of an array of perforations on the composite outer wrapper **38** provides uniform combustion of the underlying ignition element **36** and tobacco **40**. Larger perforations **64** near the rear of the section **41** open when the ignition element acquires sufficient thermal energy to provide further flow rate control.

If desired, the cigarette wrapper according to the invention can be used with a cigarette wherein the ignition element **36** is omitted. The wrapper can incorporate features discussed above in connection with Figures 3(a), 4 and 5(a-c).

The above-described exemplary embodiments are intended to be illustrative in all respects, rather than restrictive, of the present invention. Thus the present invention is capable of many variations in detailed implementation that can be derived from the description contained herein by a person skilled in the art. All such variations and

modifications are considered to be within the scope and spirit of the present invention as defined by the following claims. For instance, although the above-discussion has been framed in the context of cigarettes, the invention extends to any smoking article. Furthermore, the section **41** of smoking material is not limited to tobacco, but can comprise any substrate containing flavor released upon combustion.